SERDP Ecosystem Management Project's

Integration Plan

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October 7, 2003

Focus of integration is on:

- Identifying indicators of ecological impacts of prior resource use or management.
- Determining how these indicators can be an integral part of the monitoring and management program of Fort Benning
- Developing a procedure for integration (so the approach could be adopted by other DoD installations)

Background (continued)

- Much research on indicators is occurring at Fort Benning
  - Three SEMP indicator projects
  - Two SEMP threshold projects
  - Endangered species research

- Other research focuses on areas outside Fort Benning
  - Modeling of environmental impacts in region
  - Climate change projections

Indicators are Focus of Much Research

- New journal: *Ecological Indicators*
- Heinz report: *The State of the Nation's Ecosystems*
- National Academy report: *Ecologic Indicators for the Nation*
- EPA's *Report on the Environment*
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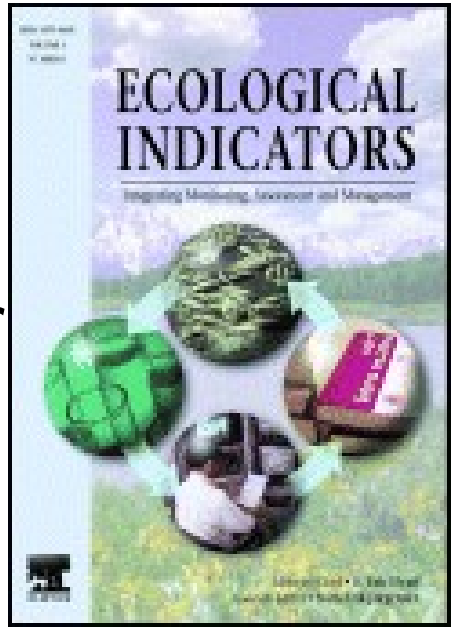


But many efforts do not focus on level of resource management

Reports demonstrate the many gaps in information about indicators

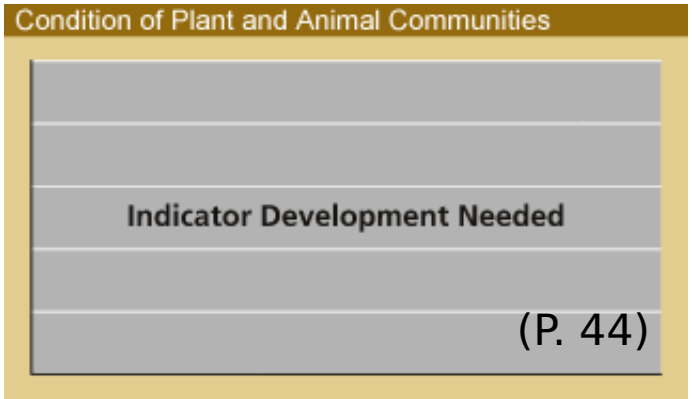
National Academy report:

"Only rough estimates of the value to society of ecological goods and services are available" (p. 26)

EPA's Report on the Environment:

- "Further exploration of the relationship between measurements used for assessments and measurements used for diagnosis of causal factors … is needed" (p. v)
- "The availability of data were too limited in place or time to describe national trends, or even to provide a national snapshot of conditions" (p. vi)

Heniz Report: illustrates data gaps



SEMP is developing indicators to provide managers with information on how military use & resource management can coexist

Fort Benning is "Home of the Infantry"

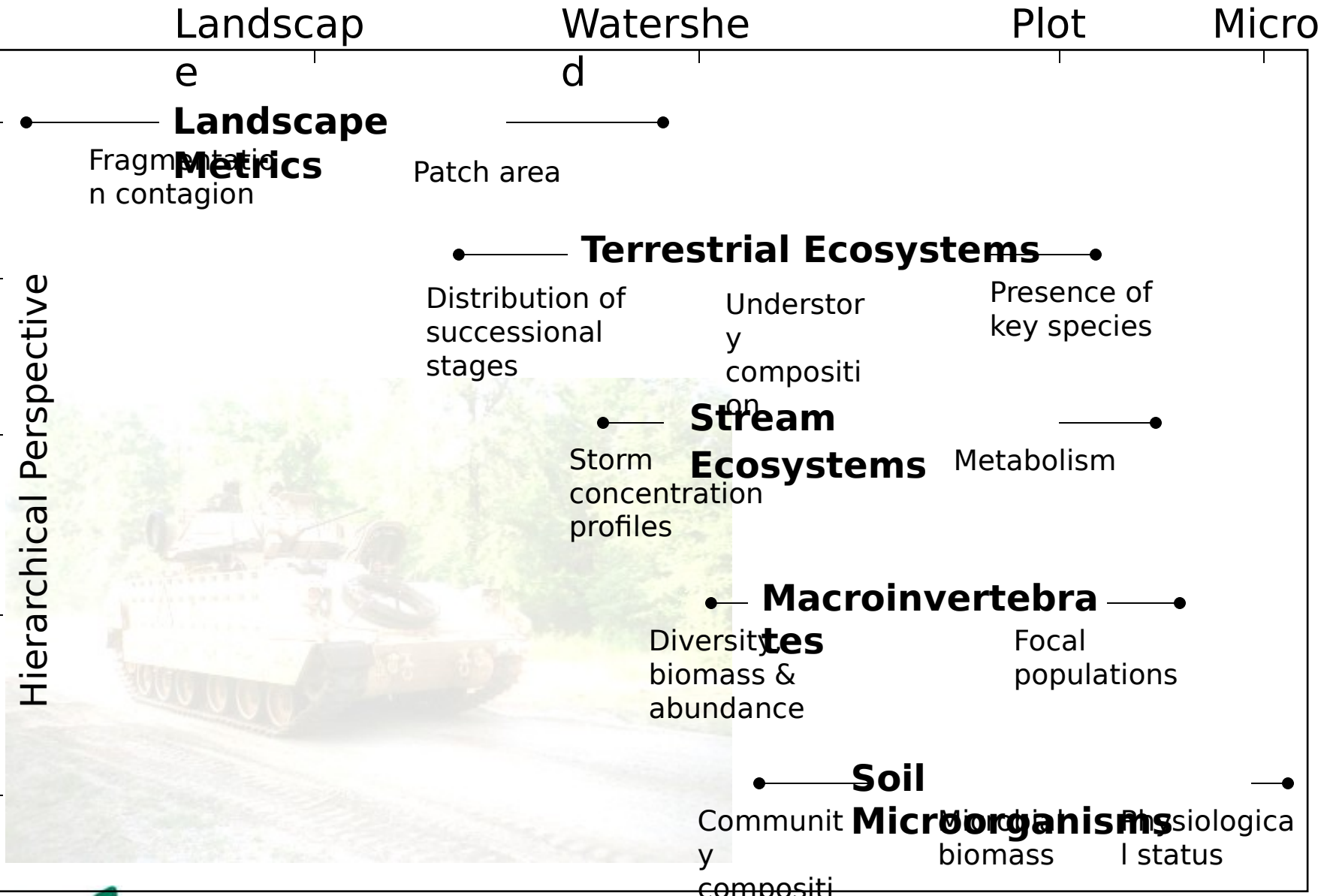
Foot traffic causes ~~compacti~~on

These forests also support endangered species

Fire is required to maintain bird habitat

How does management for the endangered species affect trai~~ning~~?

APPROACH: Suite of Ecological Indicators



ORNL Oak Ridge National Laboratory
ERDP's SEMP

Some Candidate Indicators for Plot Scale

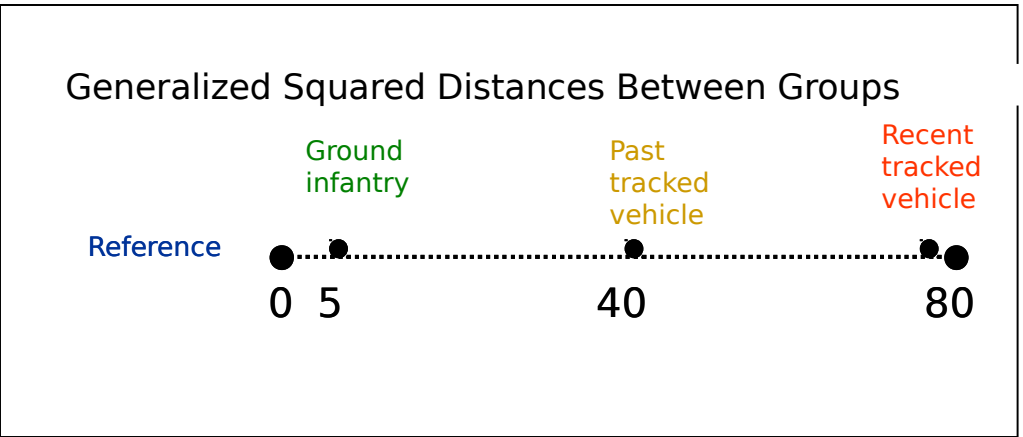
- Vegetation
  - Tree density & diversity
  - Understory cover & diversity
  - Cover by life form
- Soils
  - Depth of A horizon
  - Surface soil carbon concentrat
  - Surface soil bulk density
- Animals
  - Ant community structure
- Multivariate metrics
  - Habitat canonical variate
- Soil fungi

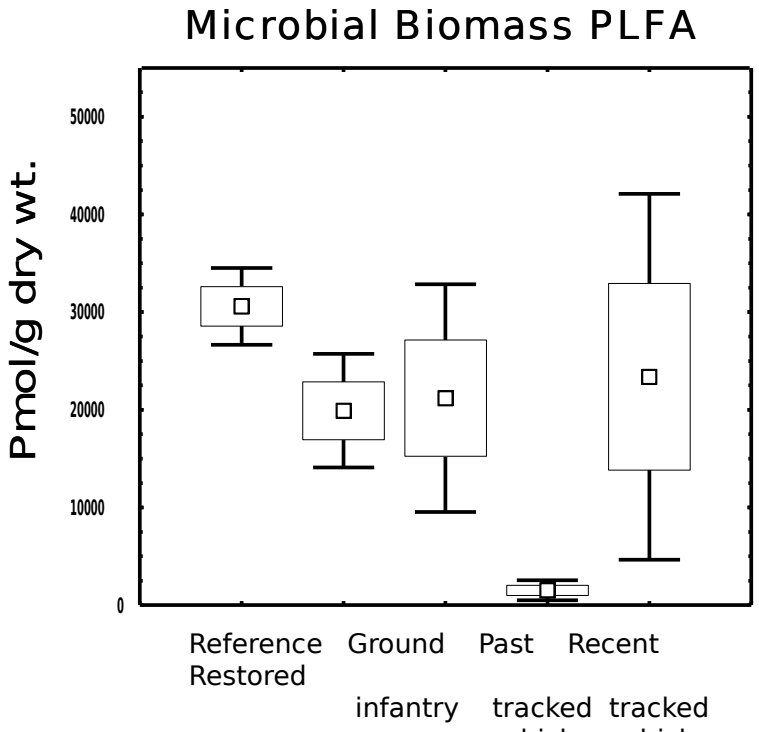
ERDP's SEMP

Analysis of soil microbial community

- **Benefits:**
  - **Easy collection of soil cores**
  - **Ship frozen**
  - **Base or commercial laboratory for analysis**
  - **Readily interpretable definition and potential for reversibility**

(Interpretation guide will be provided to resource managers so soil microbiota results will not require special expertise to interpret)

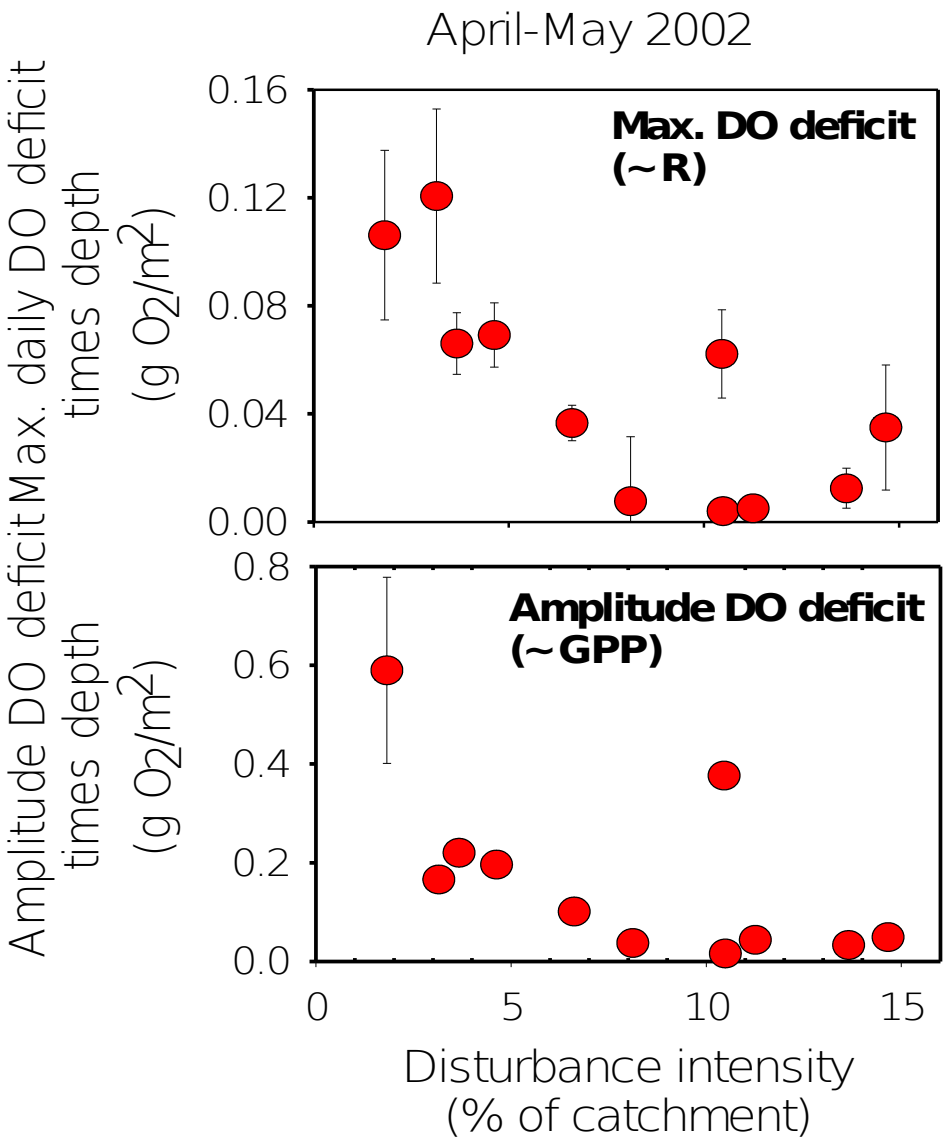




Candidate Indicators at Catchment Scale

- Stream chemisty
  - Suspended sediment and nutrient concentrations
    - -- (indicator of erosion and biogeochemical status)
  - Diurnal dissolved oxygen profiles
    - – (indicator of in-stream metabolism)
  - Streambed organic matter content
    - – (indicator of food or habitat)
  - Sediment movement dynamics
    - (indicator of in-stream habitat stability or quality)
- Macroinvertebrate populations and communities
  - EPT richness
  - Shannon diversity

Indicator of stream metabolism:
Maximum DO deficit, Amplitude DO deficit

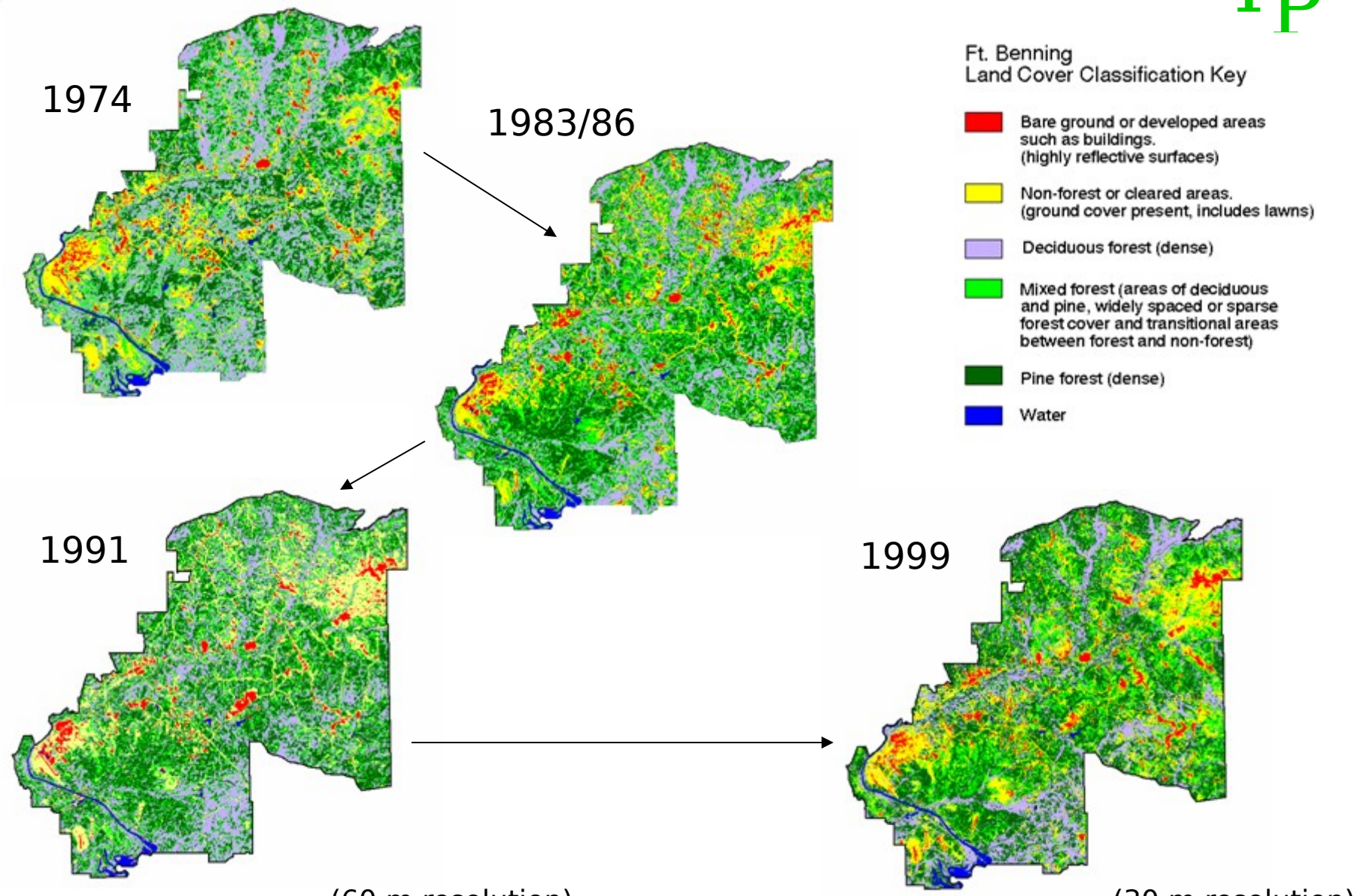


Low disturbance

High disturbance

Candidate Indicators for Entire Installation

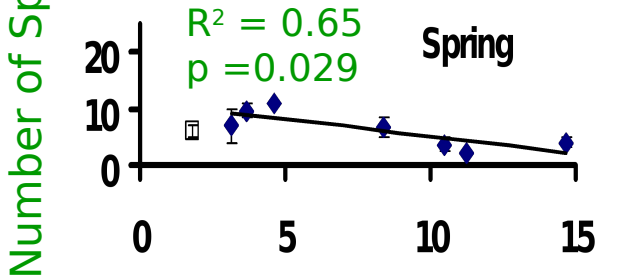
- Landscape metrics
  - area covered by forest type
  - total edge (m)
  - landscape composition
  - number of habitat patches
  - descriptors of patch area
  - nearest neighbor distance
  - clumpiness


1974
1983/86
1991
1999
Ft. Benning
Land Cover Classification Key
Bare ground or developed areas such as buildings. (highly reflective surfaces)
Non-forest or cleared areas. (ground cover present, includes lawns)
Deciduous forest (dense)
Mixed forest (areas of deciduous and pine, widely spaced or sparse forest cover and transitional areas between forest and non-forest)
Pine forest (dense)
Water
(60 m resolution)
(30 m resolution)

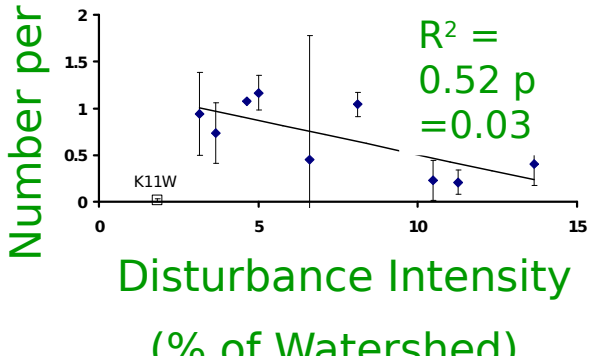
Integration with Other Indicator Efforts

- Criteria for indicators built upon previous efforts
- Specific indicator derived from other studies
  - e.g., EPT and other groups of insects
- SEMP work fits into hierarchy of indicators
  - National
  - Broad regions
  - Management regions (e.g., Fort Benning)

Number of EPT Taxa



Density of *Procambarus versutus*



Flowchart for Integration

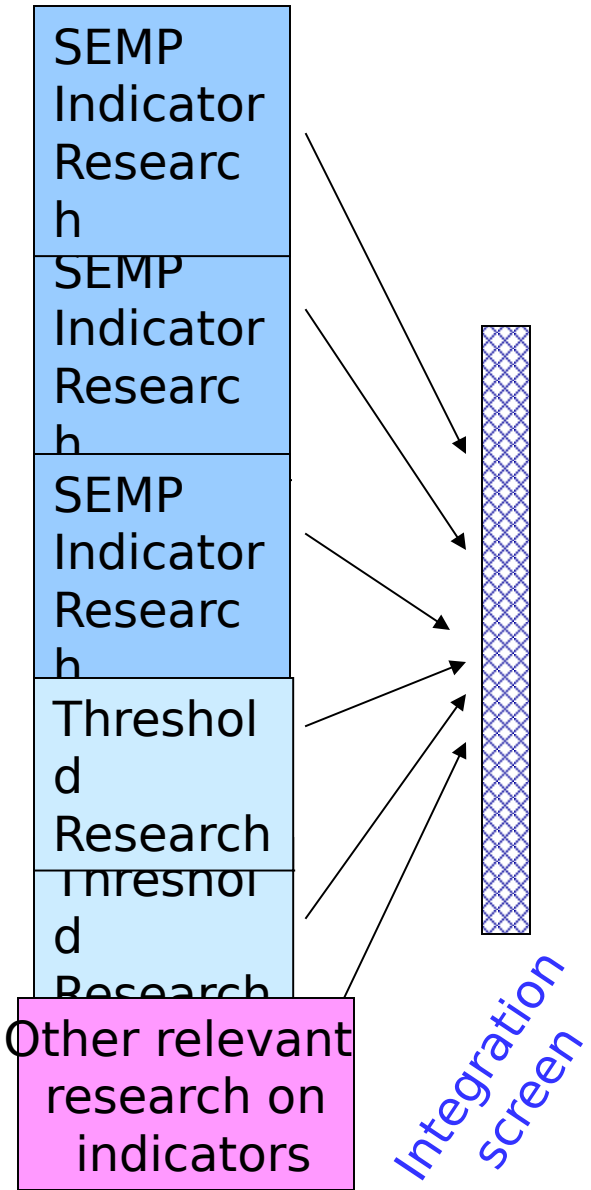
1. Determine criteria to be used for indicator selection
2. Develop integration screen
3. Determine discrete land-use categories
4. Assign each data set to a land-use category
5. Assess ability of indicators to differentiate between land uses
6. Subject indicators to management needs screen
7. Incorporate resulting indicators into monitoring and analysis plan

1.Determine criteria for Ideal Set of Indicators

- **Build on Dale & Beyeler (2001)**
  - **Are easily measured**
  - **Are sensitive to stresses on system**
  - **Respond to stress in a predictable manner**
  - **Are anticipatory: signify an impending change in the ecological system**
  - **Predict changes that can be averted by management actions**
  - **Have a known response to natural disturbances, anthropogenic stresses, and changes over time**
  - **Have a narrow variability in response**
  - **Are integrative: the full suite of indicators provides a measure of coverage of the key gradients across the ecological systems (e.g., soils, vegetation types, temperature, etc.)**

- **Include input from SEMP researchers and TAC**
  - Select indicators that are broadly applicable across the system of interest and to other ecological systems
  - Consider spatial and temporal context of measure

2. Develop Integration Screen



- **Queried the three indicator and two threshold research teams as to their proposed indicators**
- **Conduct a preliminary screening of proposed metrics against the criteria for indicators**

Number of Indicators Studied/Selected

	University of Florida	Prescott College	ORNL1	ORNL 2	SREL	ECMI
Terrestrial plants & habitat	~130 / 8	23 / 2	~150 / 15	_	14 / 2	_
Terrestrial animals	_	21 / 1	_	_	1 / 1	_
Soils	34 / 3	15 / 3	_	100 / 25	29 / 6	_
Aquatic/ Riparian	12 / -	10 / 0	43 / 12	_	_	_
Hydrology	12 / 7	20 / 0	25 / 10	_	_	_
Landscape	_	_	~70 / 8	_	_	1 / 1
Microbes	20 / 10	7 / 7	72 / 19			

3. Determined discrete land-use categories

Used Delphi Process

- **Iterative process**

- **Input from group of experts:**
  - **Fort Benning resource managers**
  - **SEMP research team**

Three categories of "land management goals and endpoints"

1. Minimally managed areas
   - 1.1 Wetlands
   - 1.2 Vegetation on steep slopes
   - 1.3 Forests in impact zones

2. Managed to restore or preserve upland forests
   - 2.1 Upland forests
   - 2.2 RCW management clusters
   - 2.3 Sensitive areas designated by signs

3. Managed to maintain altered ecological state
   - 3.1 Intensive military use areas
   - 3.2 Wildlife openings
   - 3.3 Mowed fields
   - 3.4 Roads
   - 3.5 Built areas

Red cockaded woodpecker

Cause of Predominant Ecological Impact From Military Use(s) of Land

- Tracked vehicles
- Wheeled vehicles
- Foot traffic
- Designated bivouac areas
- Firing ranges
- Impact areas
- Drop and landing zones
- Not affected

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ERDP's SEMP

Land management goals	Cause of predominant ecological impact from military use(s) of land								
	Tracked vehicles	Wheeled vehicles	Foot traffic	Designated bivouac areas	Firing ranges	Impact areas	Drop zones	No effect	Admini-strative use
1. Minimally managed areas									
1.1 Wetlands	WetTrI WetTrF	WetWhI WetWhF	WetFtI	0	0	0	0	Wet+	0
1.2 Vegetation on steep slopes	SteTrI SteTrF	SteWhI SteWhF	SteFtI	0	0	0	0	Ste+	0
1.3 Forests in impact zones	0	0	0	0	0	ForImpI ForImpF	0	For+	0
2. Managed to restore and preserve upland forest									
2.1 Upland forest	UpltrI	UplWhI UplWhF	UplFtI UplFTF	0	0	0	0	Upl+	0
2.2 RCW mgmt clusters	RcwTrkI	RcwWhI	RcwFtI RcwFtF	0	0	0	0	Rcw+	0
2.3 Sensitive area designated by signs	0	0	SenFtI SenFtF	0	0	0	0	Sen+	0
3. Managed to maintain an altered ecological state									
3.1 Intensive military use areas	MilTrkF	MilWhF	0	MilBivI MilBivF	MilFirF	0	0	0	0
3.2 Wildlife openings	0	WldWhI	WldFI	0	0	0	WldDrpI	Wld+	0
3.3 Mowed fields	0	MowWhI	MowFtI MowFtF	0	MowFirI MowFirF	0	MowDrpI MowDrpF	Mow+	0
3.4 Roads (paved and unpaved)	RdtrI RdTrF	RdWhI RdWhF	RdFtI RdFtF	0	0	0	0	Rd+	0
3.5 Built areas	0	0	0	0	0	0	0	0	Ba

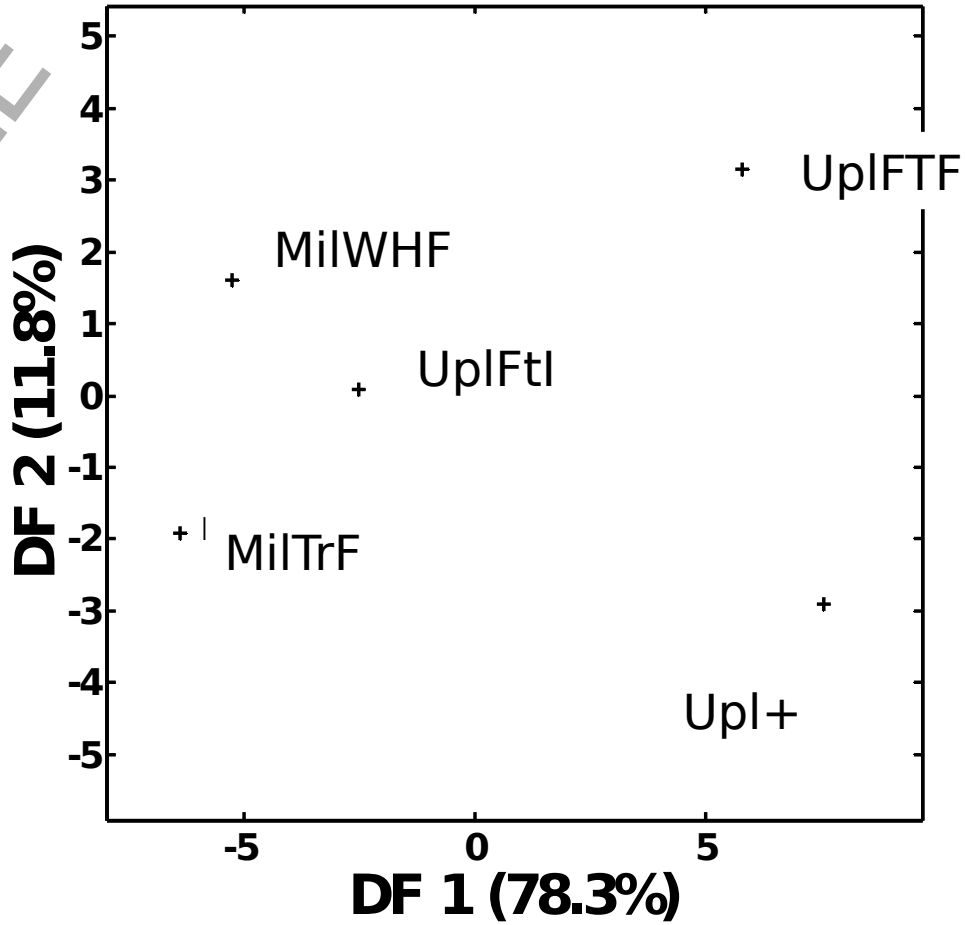
4. Assign data set to a land use category

- **Have researchers assign a land-use category to each plot**
- **Acquire data from the SEMP repository (as entered by researchers) for successfully s**

5. Assess ability of indicators to differentiate between land uses

- **Multivariate analysis of the proposed indicators**
- **Treat land-use categories as independent variables**

EXAMPLE



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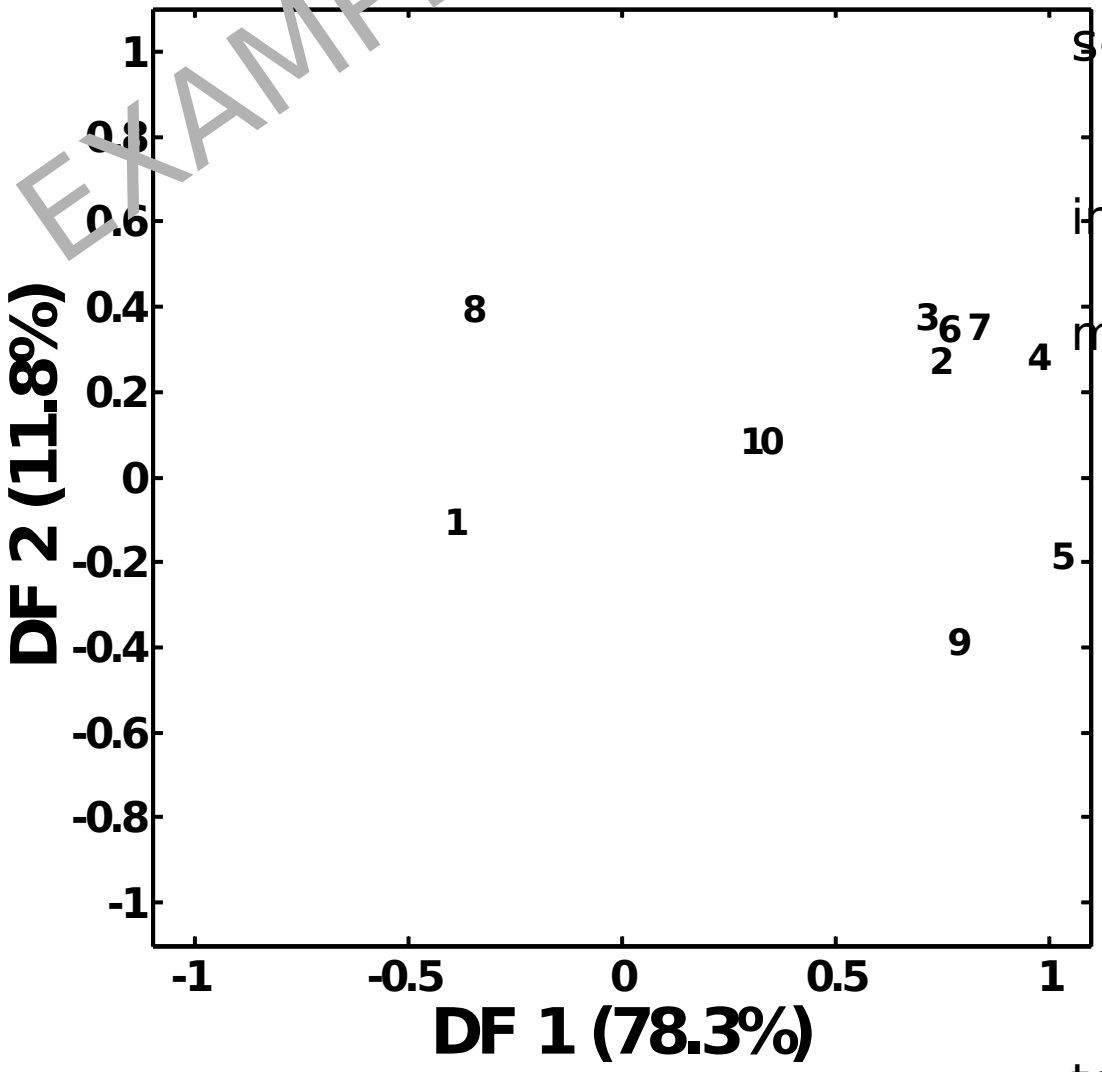
Ten variables (soils, vegetation. and microbes) explain 90% of variance

EXAMPLE



Represent a diversity of sectors:

Microbial

1. Bacterial fatty acid indicative of gram positive microbes

Soil

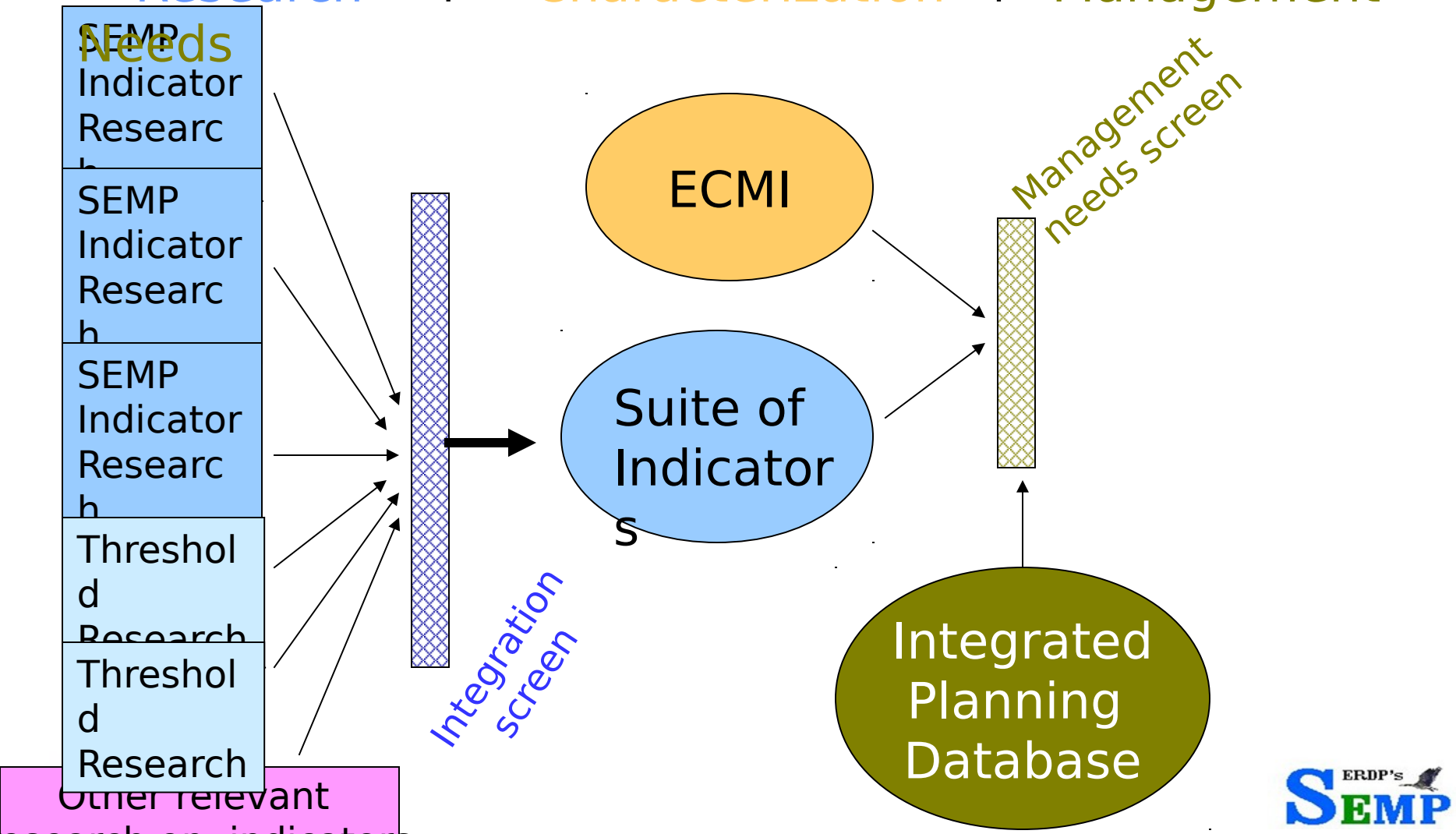
2. Carbon storage
3. Carbon stock

Vegetation

4. Tree age
5. Canopy cover
6. Understory cover
7. Number of understory species
8. Cover of annual species
9. Cover of legumes
10. Cover of plants in

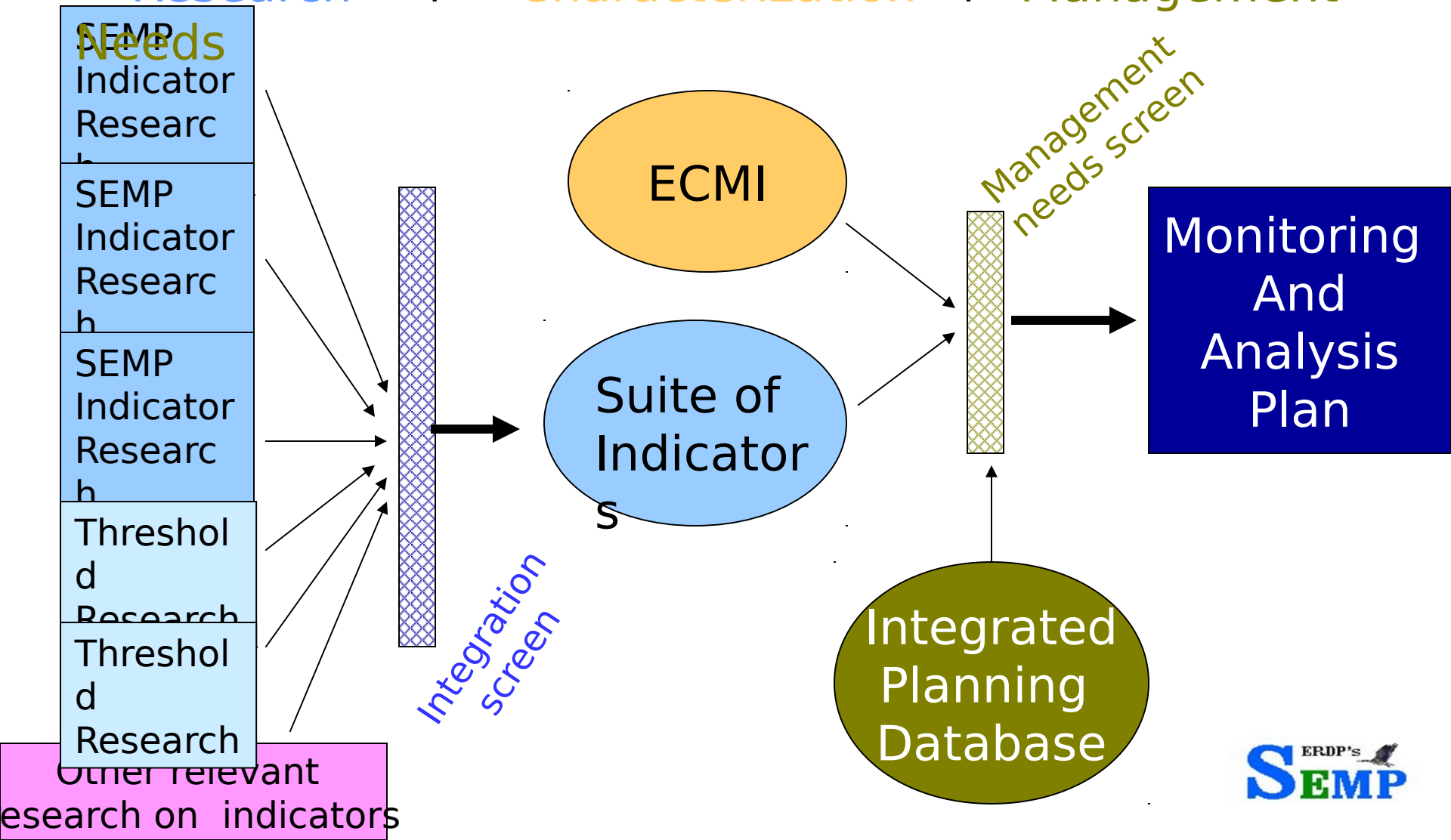
6. Subject indicators to management needs screen

= Research + Characterization + Management

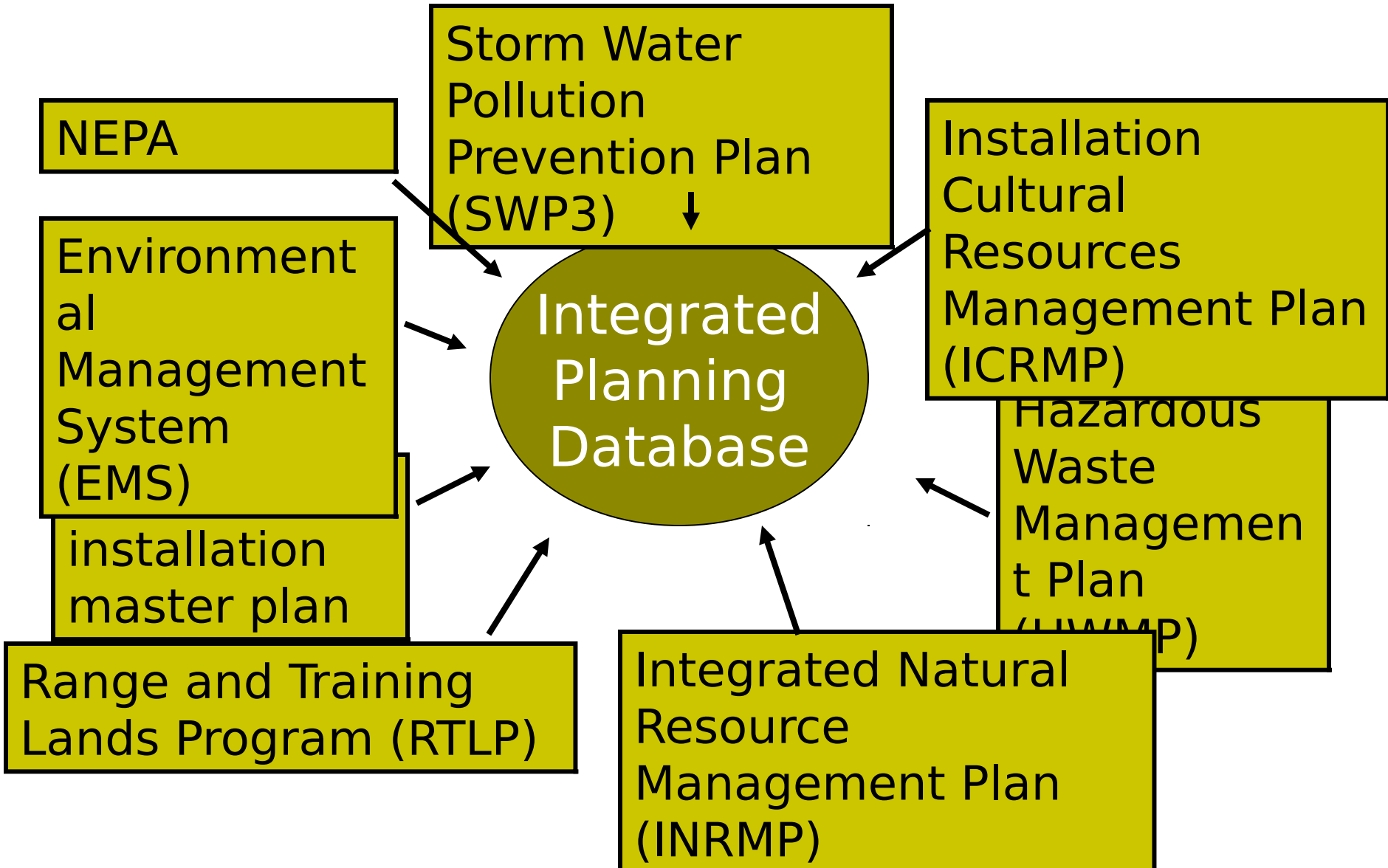


7. Incorporate resulting indicators into monitoring & analysis

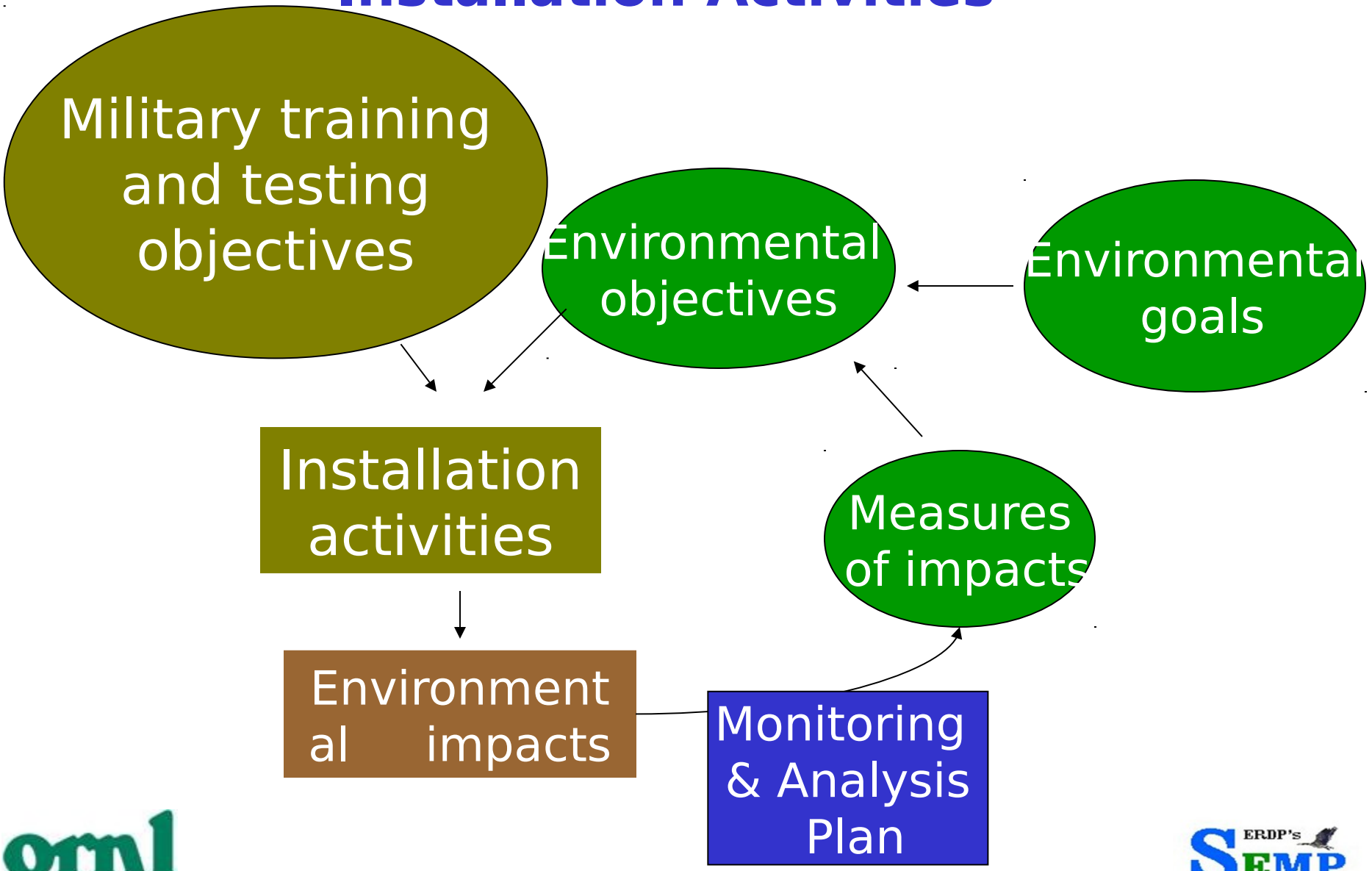
= Research + Characterization + Management



Indicators must be put in context of management needs


Storm Water Pollution Prevention Plan (SWP3)
NEPA
Environmental Management System (EMS)
Installation Cultural Resources Management Plan (ICRMP)
Integrated Planning Database
Hazardous Waste Management Plan
installation master plan
Range and Training Lands Program (RTLP)
Integrated Natural Resource Management Plan (INRMP)

Monitoring Plan Fits into Overall Installation Activities



How are SEMP results being used at Fort Benning?

- Led to focus on desired future conditions
- Develop relationship between goals for environmental management and military use
- Contribute directly to monitoring plan
- Illustrate how adaptive management approach can be implemented

Schedule

- April 2003: Query to SEMP researchers
- July 2003: Results of compiled query on proposed indicators.
- September 2003: Land-use categories derived from existing land-use groups and Delphi method.
- November 2003: SEMP teams assign land-use categories to plots
- January 2003: Results of preliminary screening of the proposed indicators against the criteria for indicators
- June 2004: Identification of key management needs for management screen
- September 2004: Multivariate analysis of the proposed indicators that make it through the first screen against land-use categories
- October 2004: Results of second screening for management needs
- March 2005: Components of monitoring and analysis plan

TAC Suggestions for Integration and Response

Virginia Dale

TAC Review

October 7, 2003

Fort Benning, Georgia

TAC Suggestions for Integration and Response

- "Dynamic Planning Toolbox" became "Integrated Planning Database"
- INRMP's ecological group concept was evaluated with input from Tom Greene, Maureen Cunningham & Rob Addington as to its use in defining the land-use categories. As detailed in our report to SEMP, the incompatibility between land cover and land use made the linkage not useful.
  - *Land cover* is the ecological state and physical appearance of the land surface (e.g., closed forests, open forests, or grasslands) (Turner and Meyer 1994). Change in *land cover* converts land of one type of cover to another, regardless of its use. *Land cover* is also affected by natural disturbances, such as fire and insect outbreaks, and subsequent changes through succession.
  - *Land use* refers to the purpose to which land is put by humans (e.g., protected areas, forestry for timber products, plantations, row-crop agriculture, pastures, or human settlements) (Turner and Meyer 1994). Change in *land use* may or may not cause a significant change in *land cover*. For example, change from selectively harvested forest to protected forest will not cause much discernible cover change in the short term, but change to cultivated land will cause a large change in cover.

TAC Suggestions for Integration and Response (Continued)

- "Evaluate use of training use distribution map that is available through the ATTACC model team (as one possible input into the site condition ratings)"
  - Info passed onto Hal and Tony for their use in defining site condition.

- Develop time frame and budget for Integration effort and include the specific data requirements that will impacts PIs selection of their indicators
  - Budget and timeline were part of January 2003 proposal
  - Timeline was updated at Sept 2003 meeting in Gainesville with concurrence from SEMP project leaders

- Define how threshold projects will be integrated and evaluated with the indicator projects
  - Input from threshold projects will be included in analysis
  - Caveats included as necessary

TAC Suggestions for Integration and Response (Continued)

- Gain concurrence on set of indicators by the TAC
  - Suggested additions
    - Can be applied efficiently by land managers in an adaptive management context
      - The full text says ”The indicator should be straightforward and relatively inexpensive to measure. The metric needs to be easy to understand, simple to apply, and provide information to managers and policymakers that is relevant, scientifically sound, easily documented, and cost-effective.”
      - We deliberately did not use the term “adaptive management” because it is not understood by all resource managers
    - Are similar to indicators used in regional and national programs that monitor ecosystem status
      - We did not want to impose on resource mangers the need to check each proposed indicator against other regional and national programs. Often the other programs have different goals and emphasis than the military lands. We assume each research team is building on established science to select their candidate indicators.

TAC Suggestions for Integration and Response (Continued)

- Gain concurrence on set of indicators by the TAC (continued)
  - Suggested changes
    - "Experience changes that can be averted by management actions" to "signal need to management action before system condition is irreversible"
      - The proposed wording suggests a need to know when system change is irreversible (but over what time frame?). We do not want to impose this difficult task on the resource managers.
    - "have a know response to natural disturbances and changes over time" to "have a known natural [… or historical] range of variability that also accounts for changes in response to natural disturbance regimes"
      - The original wording is "have a known response to disturbances, anthropogenic stresses, and changes over time." We do not want to use natural or historical range of variability, for that would call for a whole body of research that a military installation may not be able or willing to support.

TAC Suggestions for Integration and Response (Continued)

- Gain concurrence on set of indicators by the TAC (continued)
  - Suggested changes (continued)
    - "have low variability in response" to "have a narrow range of variability in response to natural disturbance"
      - Dale & Beyeler says" Indicators that have a small range in response to particular stresses allow for changes in the response value to be better distinguished from background variability." Thus the variability is in response to both natural and anthropogenic disturbance. Change "low" to "narrow."

TAC Suggestions for Integration and Response (Continued)

- Gain concurrence on set of indicators by the TAC (continued)
  - Have criteria that help ensure an appropriate suite of indicators is identified. These criteria include:
    - Must account for all levels of the biological hierarchy as well as spatial and temporal scales, as appropriate
    - Must account for changes in ecological conditions as a result of both planned restoration trajectories and natural successional changes
    - Must be a complete, but reasonable limited, set of indicators appropriate for use by land managers”
  - It makes sense to include such criteria. These kind of criteria are expanded upon in an example that we have developed. However we avoid the use of “must” or “all.”

TAC Suggestions for Integration and Response (Continued)

- Define the axes of a land-use category/ecological condition matrix in comparison with the installation approach to such a management framework to ensure the transferability of the developed approach to to other installations and/or programs.
  - Fort Benning resource managers helped define the land-use categories and approved the final selection

- Address concerns of the SEMP PM from ancillary discussion on the usage of the proposed ranking scheme: keep separate rankings related top military use and forestry management
  - The land-use categories are derived from a matrix of land management goals and endpoints against cause of predominant military impact.

TAC Suggestions for Integration and Response (Continued)

- Integrate with existing and emerging installation frameworks
  - Jeff Fehmi developed a second draft of his report of the integration process that was reviewed by Benning resource managers
  - Jeff's third draft is now in review.

- Coordination with Fort Benning Resource staff to generate a mutually beneficial set of land-use categories that integrates current installation efforts to develop such categories separate form ecological condition categories
  - The initial land-use categories were established in a working session with Fort Benning resource managers & TNC staff stationed at Fort Benning
  - The Fort Benning resource managers and TNC staff have been involved in every iteration of the land-use categories from May to Sept. 2003

TAC Suggestions for Integration and Response (Continued)

- Consider and incorporate other suggestions for indicator criteria
  - Each SEMP project leaders were asked for input into the criteria, and their comments were included in final list
  - TAC comments were considered
- Define tasks and costs
  - The Jan. 2003 proposal sets forth tasks and costs
  - The timeline was adjusted in Sept. 2003 with input from all of the SEMP project leaders